Electrical Resistivity Imaging: Finally, A Way to "See" Remediation Progress

Presented By

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CONSULTING

If You're Not a Part of the Solution,
There's Good Money to be Made in Prolonging the Problem.

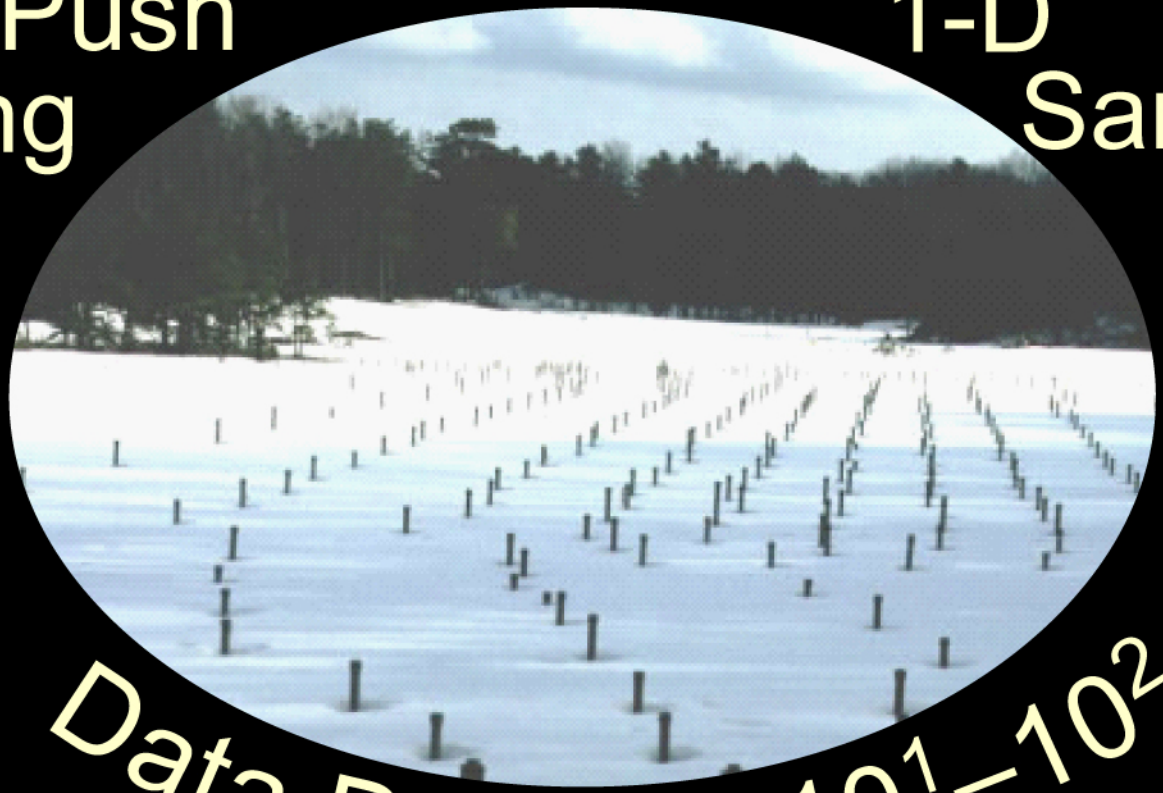
Why don’t you like to clean sites?

- How long will it take?
  1 year? 3.6 years? 25 years?
- How much will it cost?
  depends on your site- complexity
- Why are you still here?
  Because the things we have done haven’t changed your problem

Current View of the Subsurface

Direct Push
or Drilling

1-D
Sampling



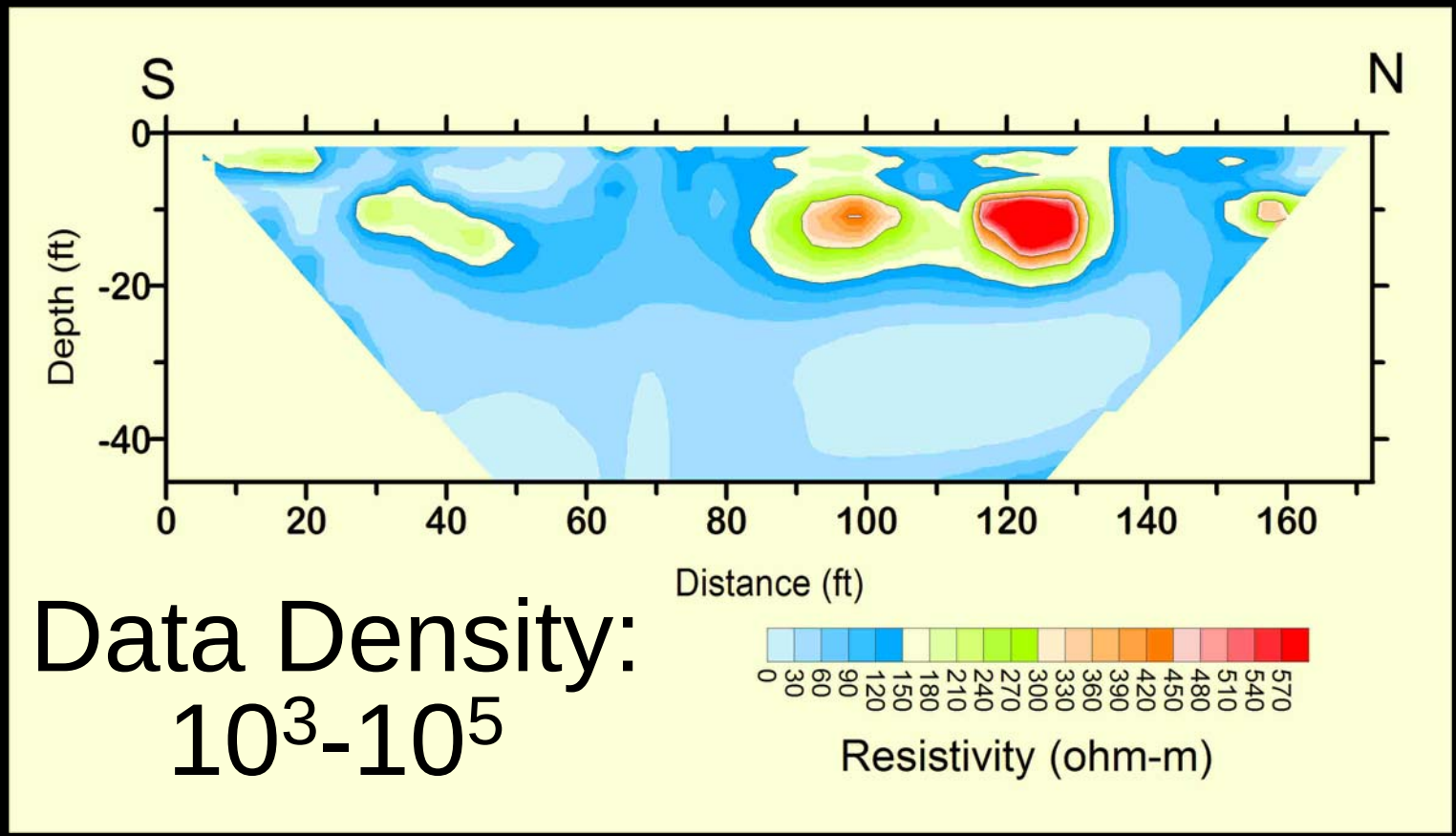
Data Density :10^1–10^2

Sampling array at the Cape Cod Site;
over 10,000 subsurface sampling ports. –USGS-

A Geotrax™ ERI View

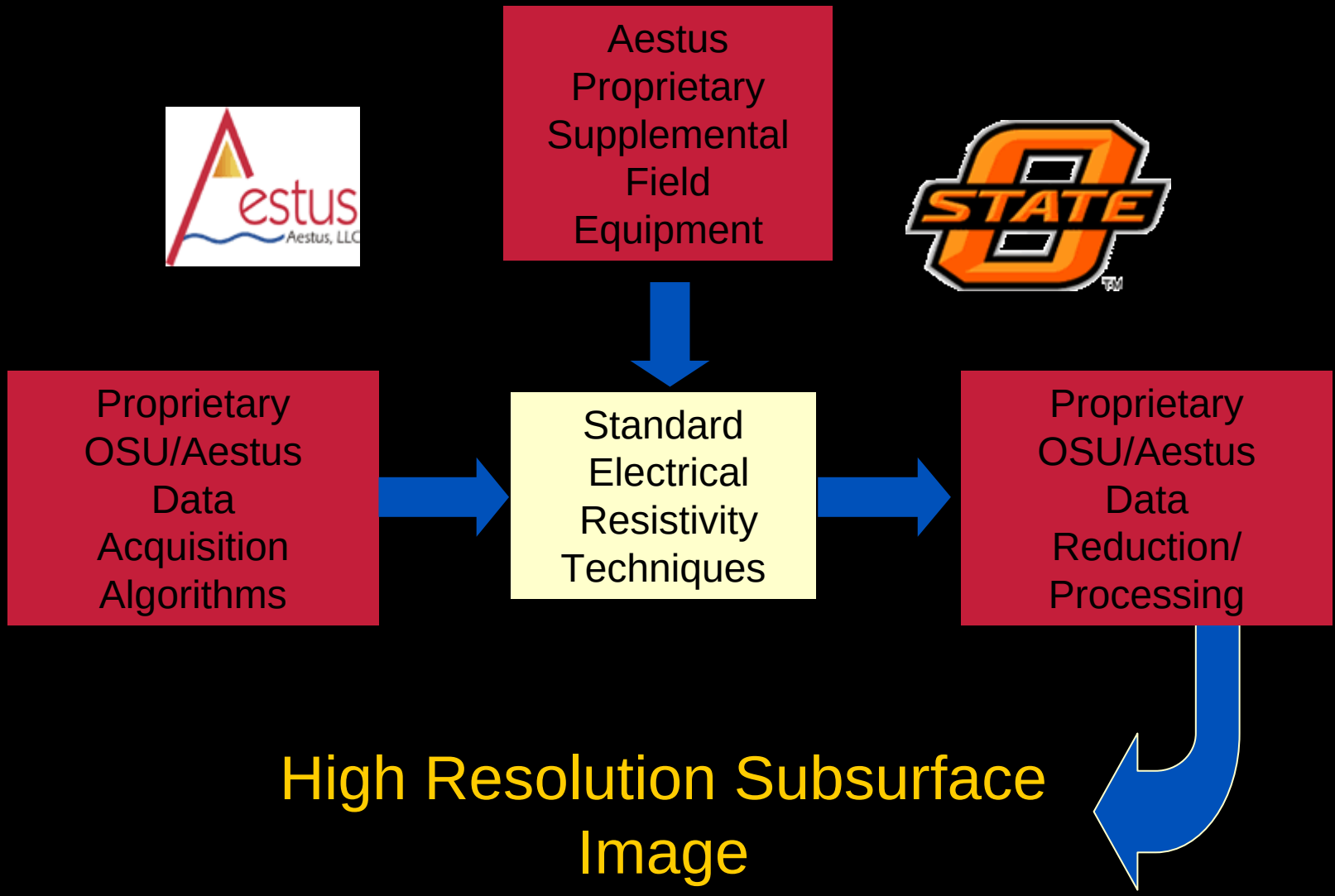
Cable at Surface 2-D,3-D, or 4-D

depth ~20% of line length

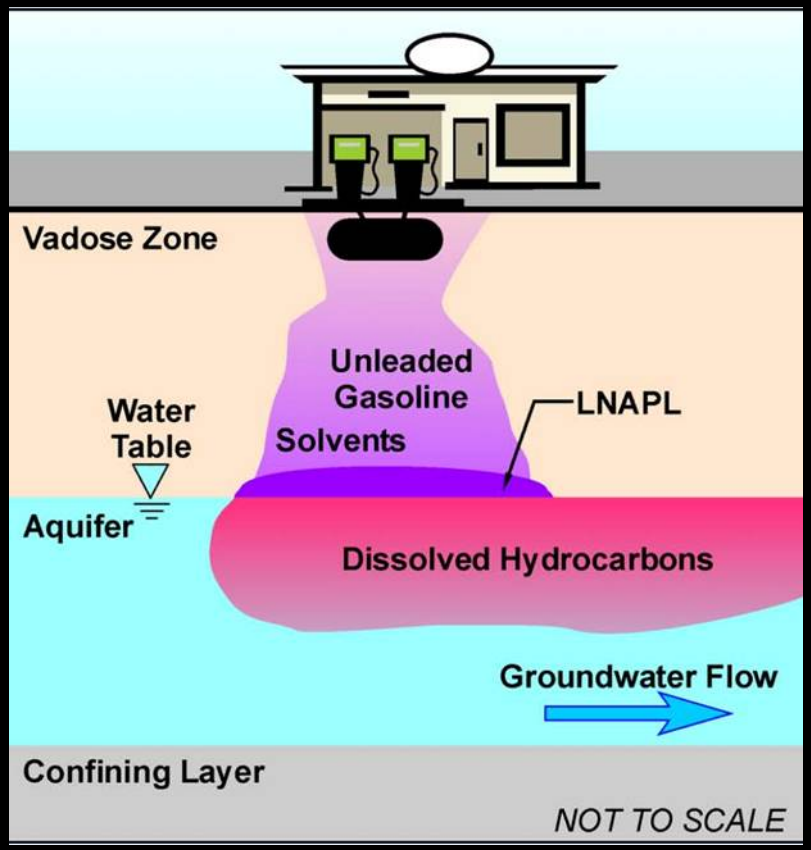


Data Density:
10^3-10^5

after Halihan et al, 2005


Aestus
Proprietary
Supplemental
Field
Equipment
Proprietary
OSU/Aestus
Data
Acquisition
Algorithms
Standard
Electrical
Resistivity
Techniques
Proprietary
OSU/Aestus
Data
Reduction/
Processing
High Resolution Subsurface Image
that is “Drillable”

What have we learned with this tool?



Naval Facilities Engineering Service Center, 2002

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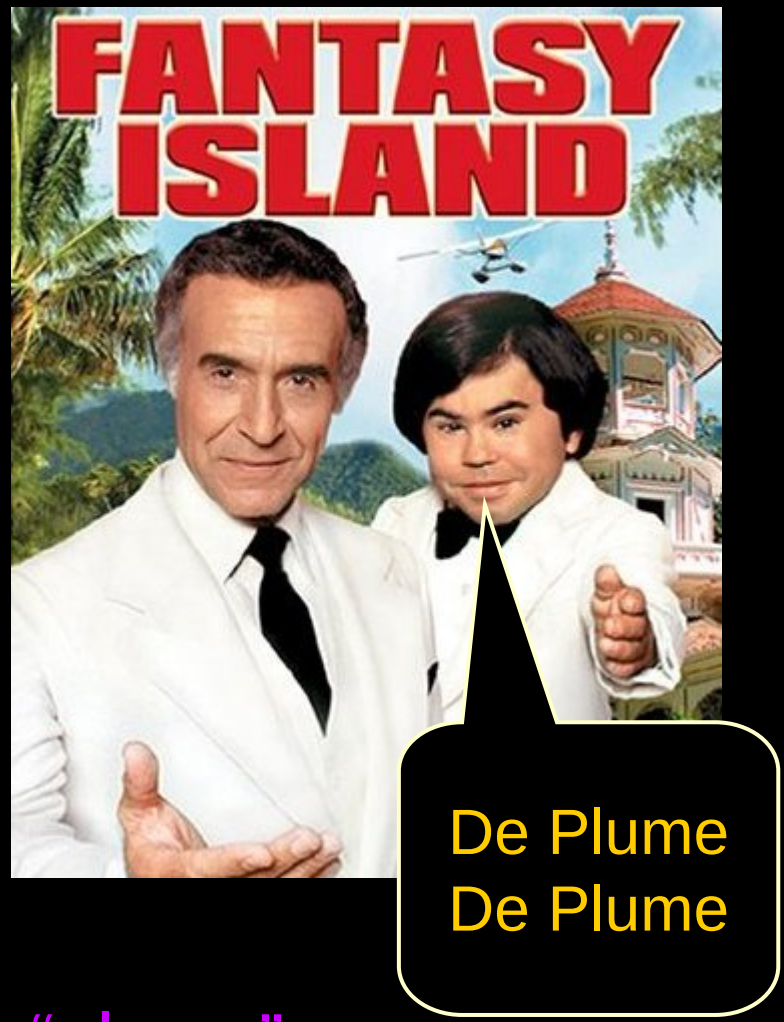
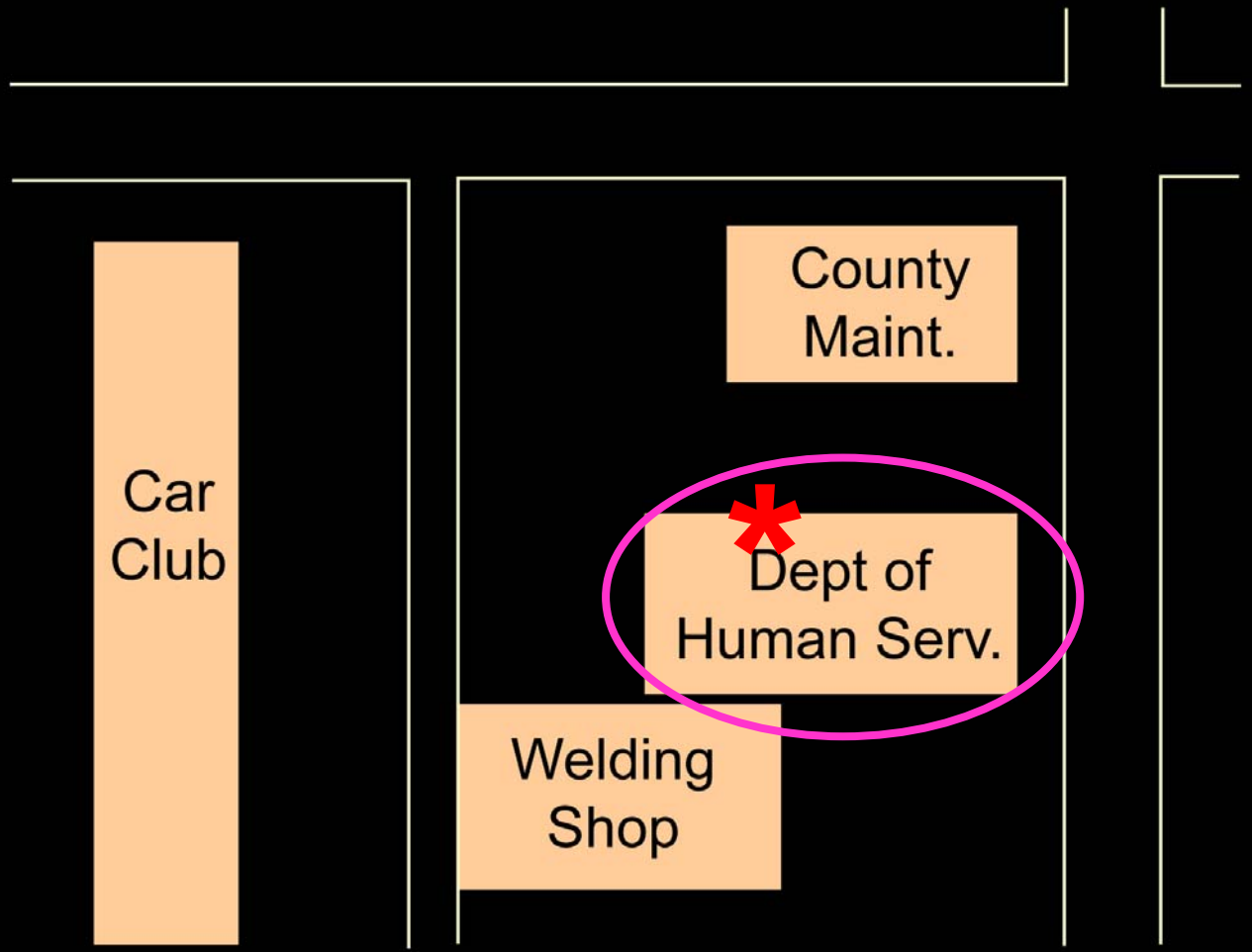


Technique has never seen a “plume”

Whodunit?



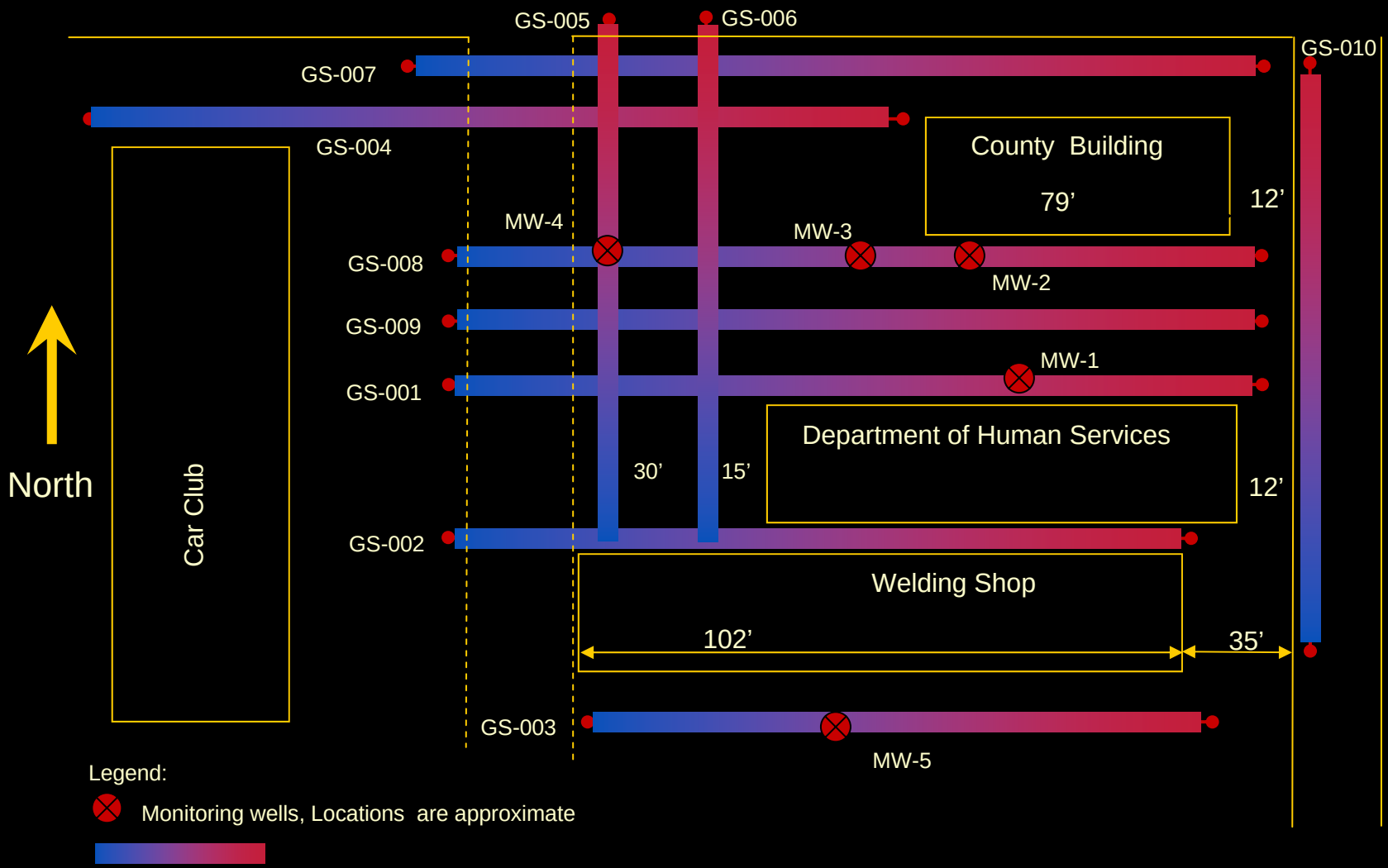
Workers at DHS complain of gasoline vapors, what is the source?

Electrical Resistivity Imaging (ERI) Investigation Gets You Closer to Reality

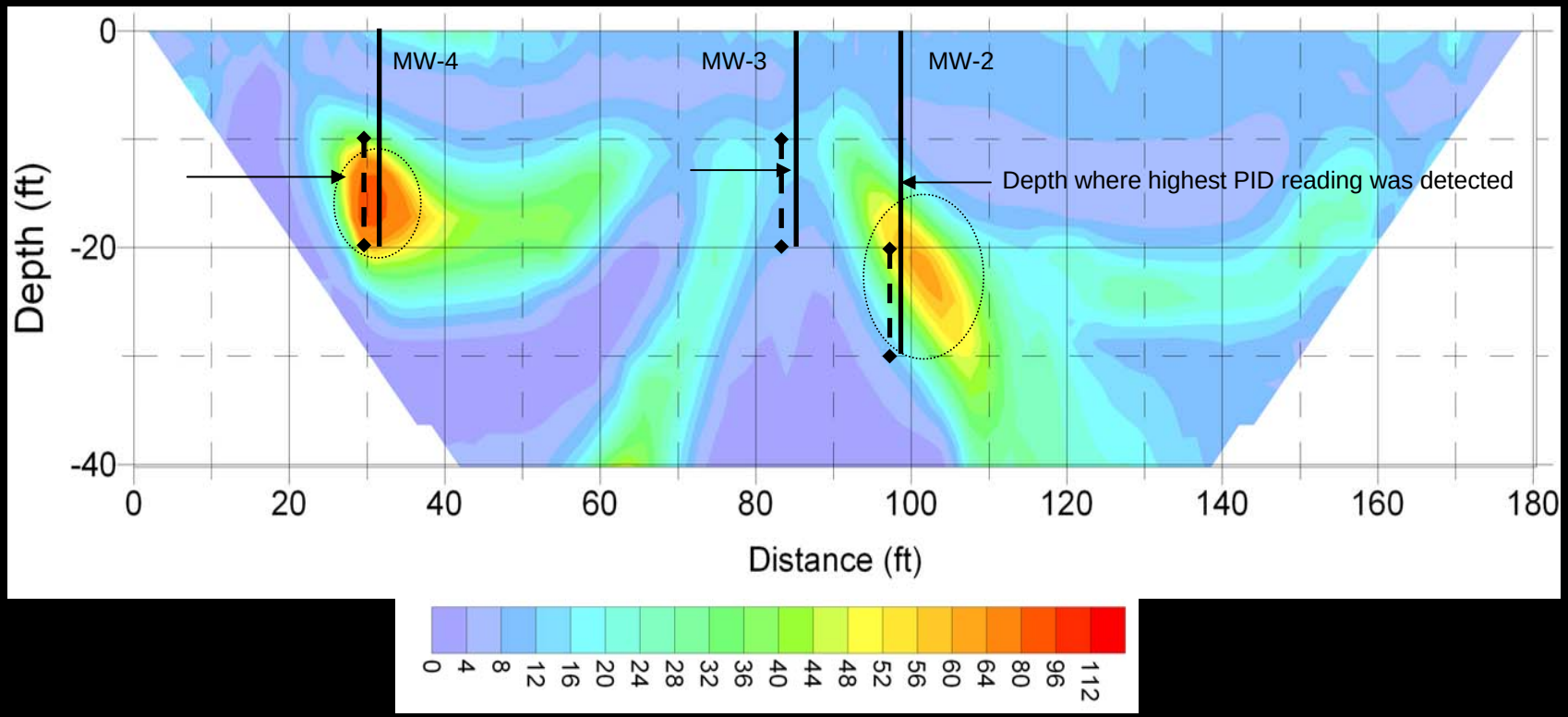
Site ERI movie

…and thus allows reality-based decisions

GeoTrax Survey™ Locations

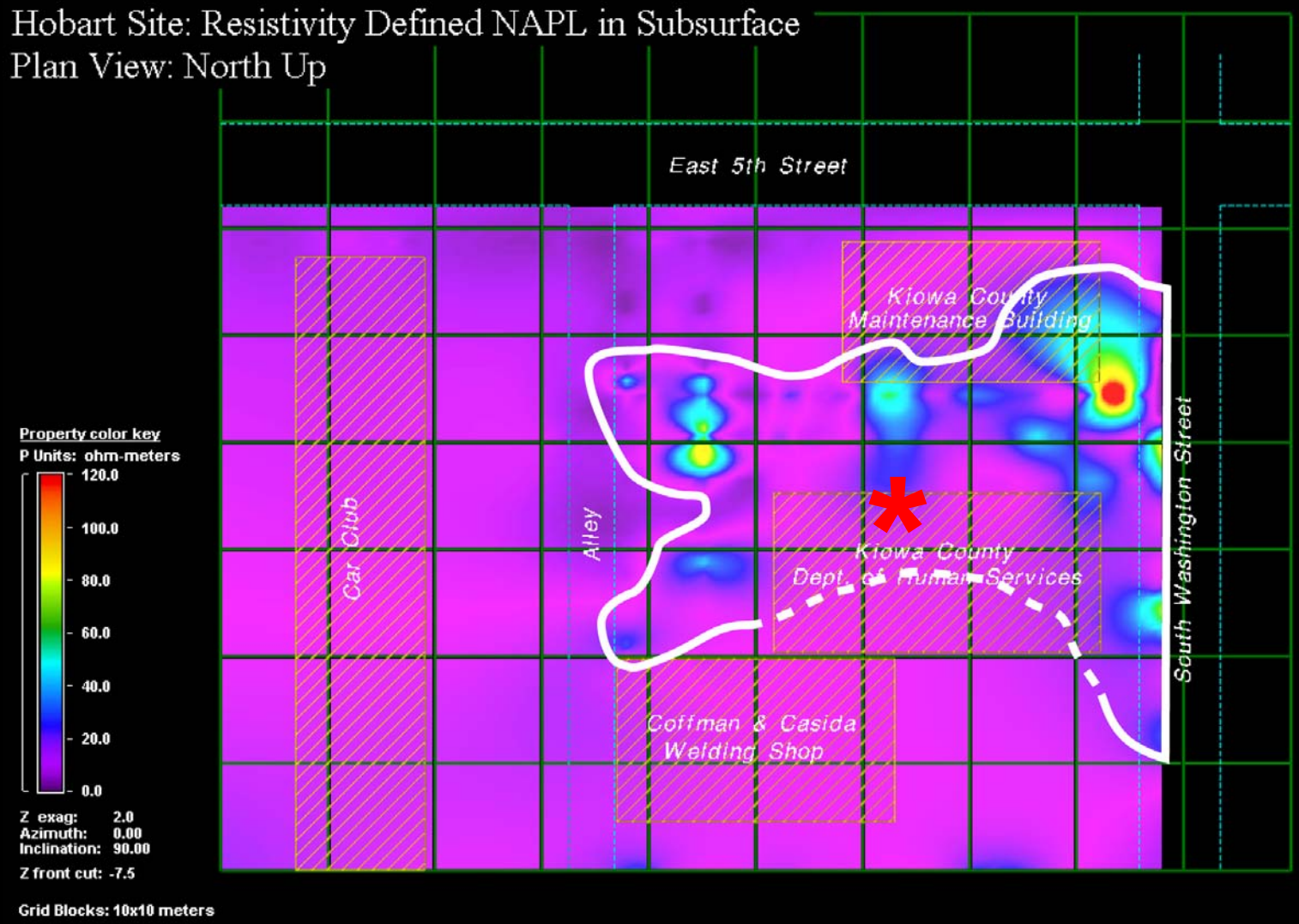


Whodunit?



LNAPL required new rig to be brought to site to drill beneath hardpan layer. Location of LNAPL in discrete “blobs”

What is a plume?



Where we have been

- EPA, States, consultants, have demonstrated that Trax Survey™ ERI technology works
- Our technology changed understanding of NAPL source behavior
- Better site characterization → Better Project Results

How ERI is applied… general protocols

- My Fantasy Island….

  I have a site I want to characterize. Can you guys help?

- Reality….

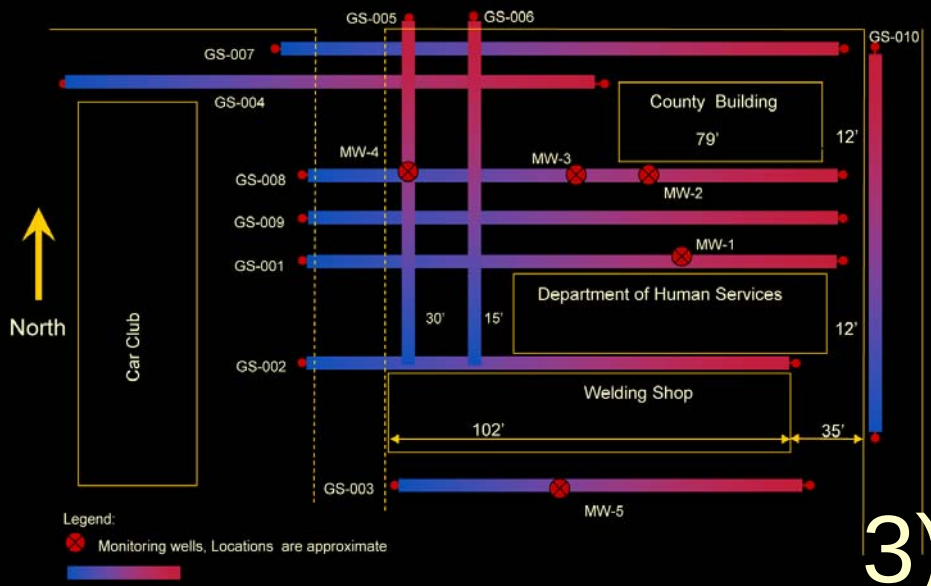
  We have this site. We've spent A LOT of money. Can you guys help?

A set of questions…

1) principal objective(s)?
2) target depths of concern?
3) previous site data?
4) current site conceptual model? – *will change, always does*
5) what contaminants? how old?
6) what have you done? Injections, etc.

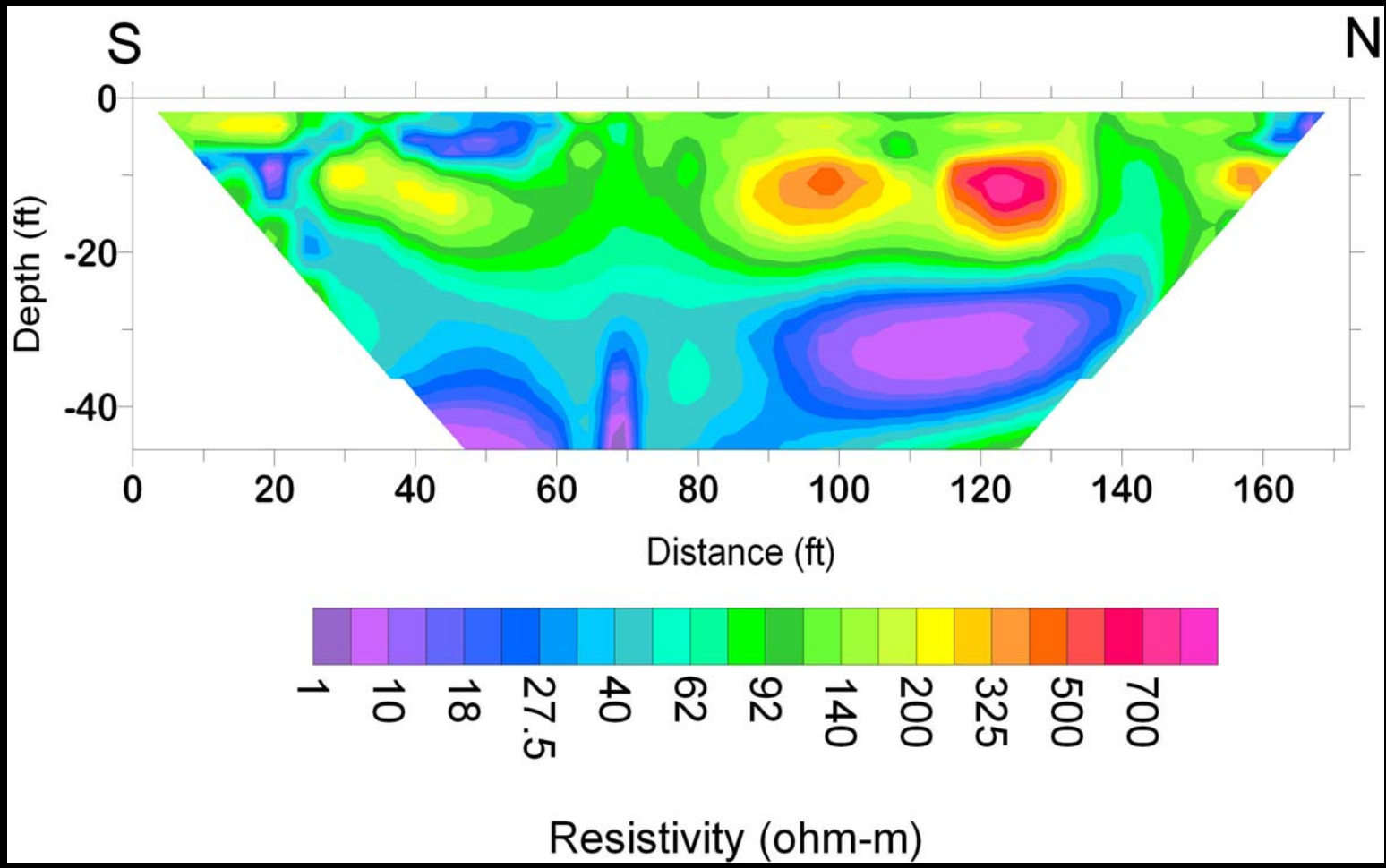
More ERI planning…

1) Number of lines ?
2) 2D, 3D or 4D ?

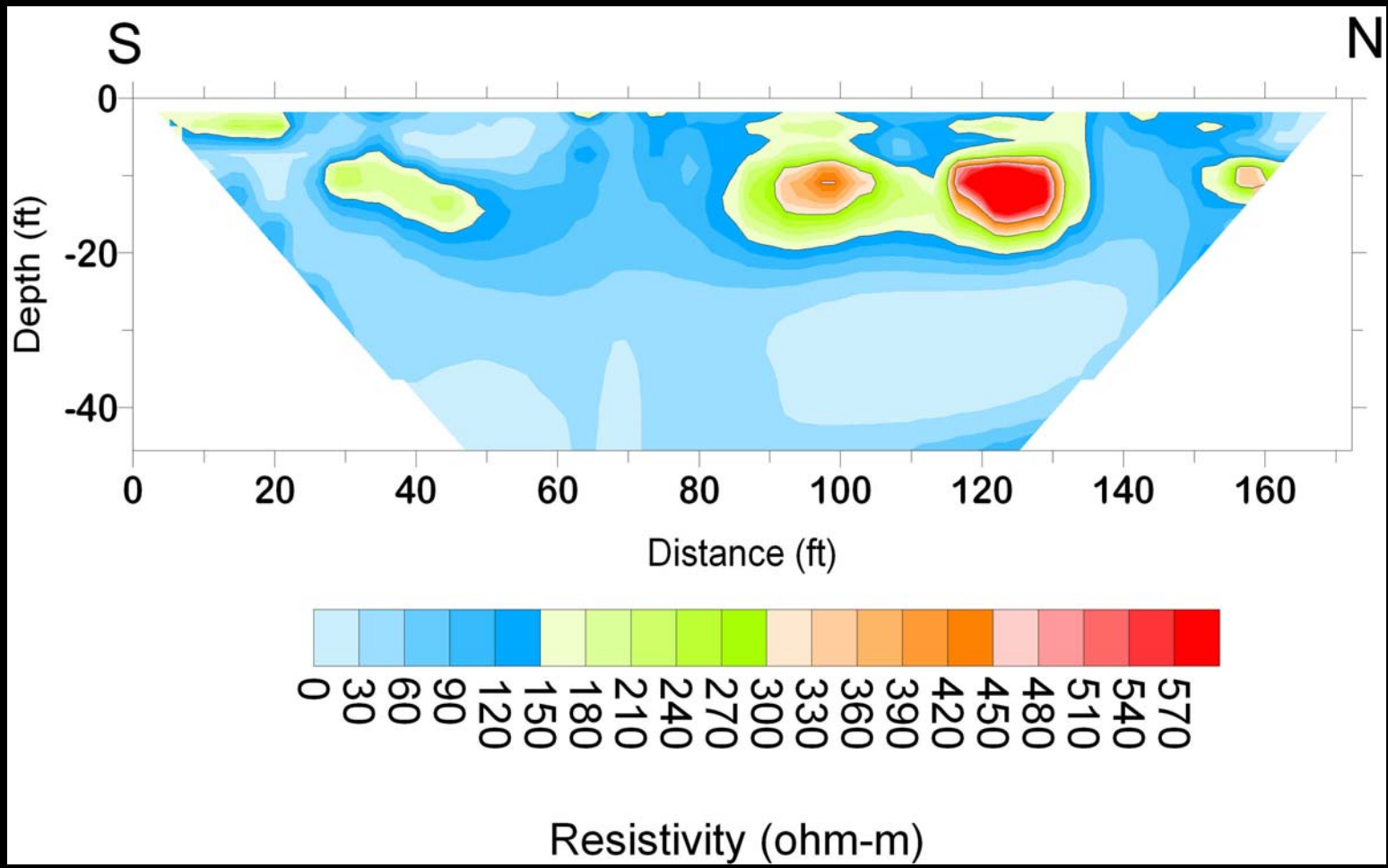


3) Surfaces of site?
4) Boundaries for work?

Collect Data, Color Image, Interpret

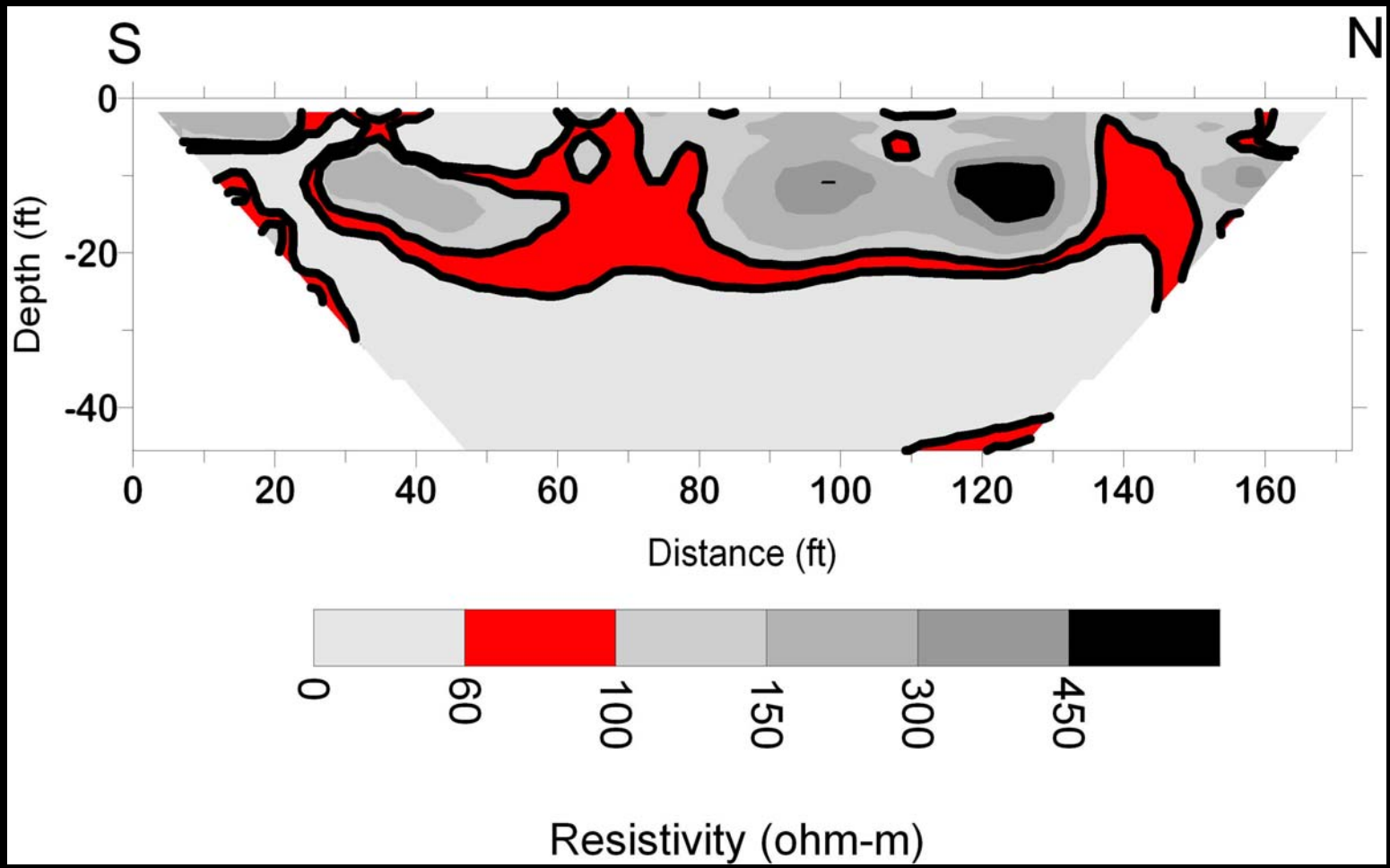


Stepped sequential image

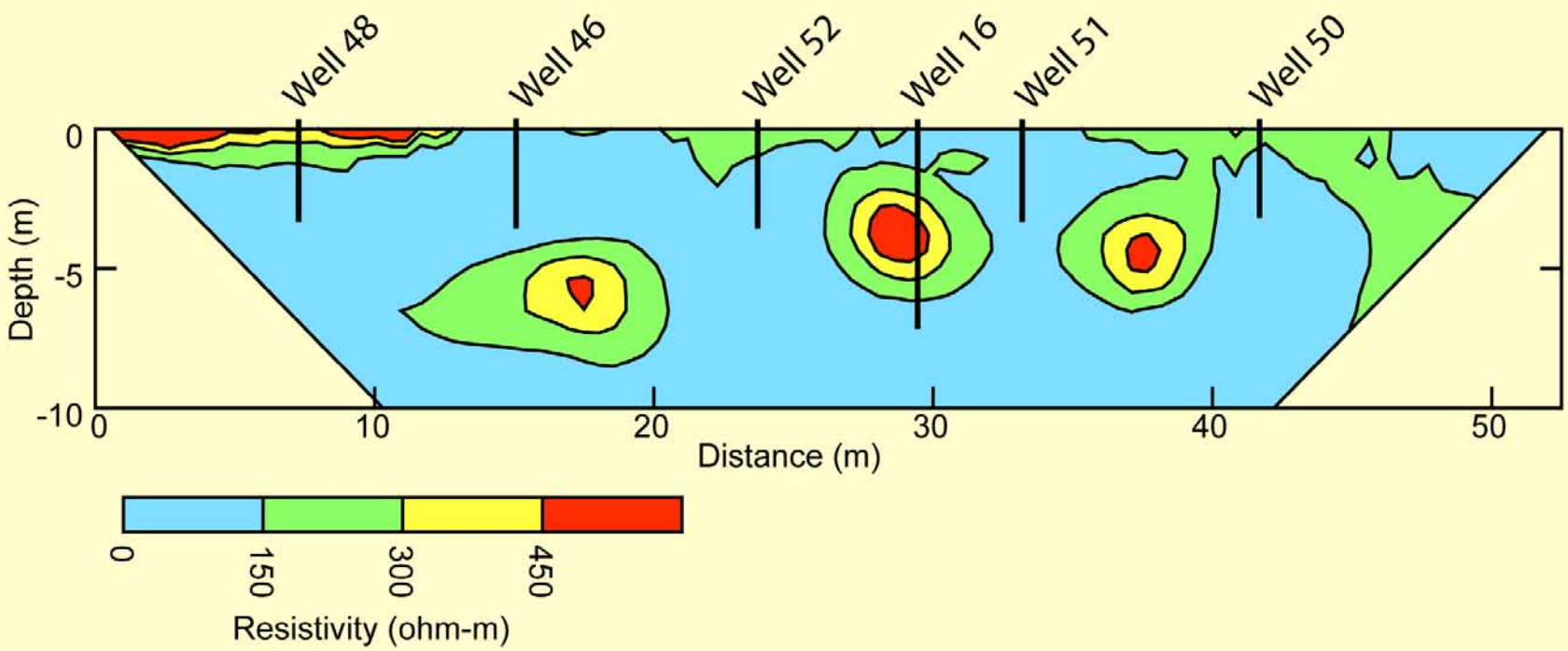


after Halihan et al, 2005

Enhanced range image



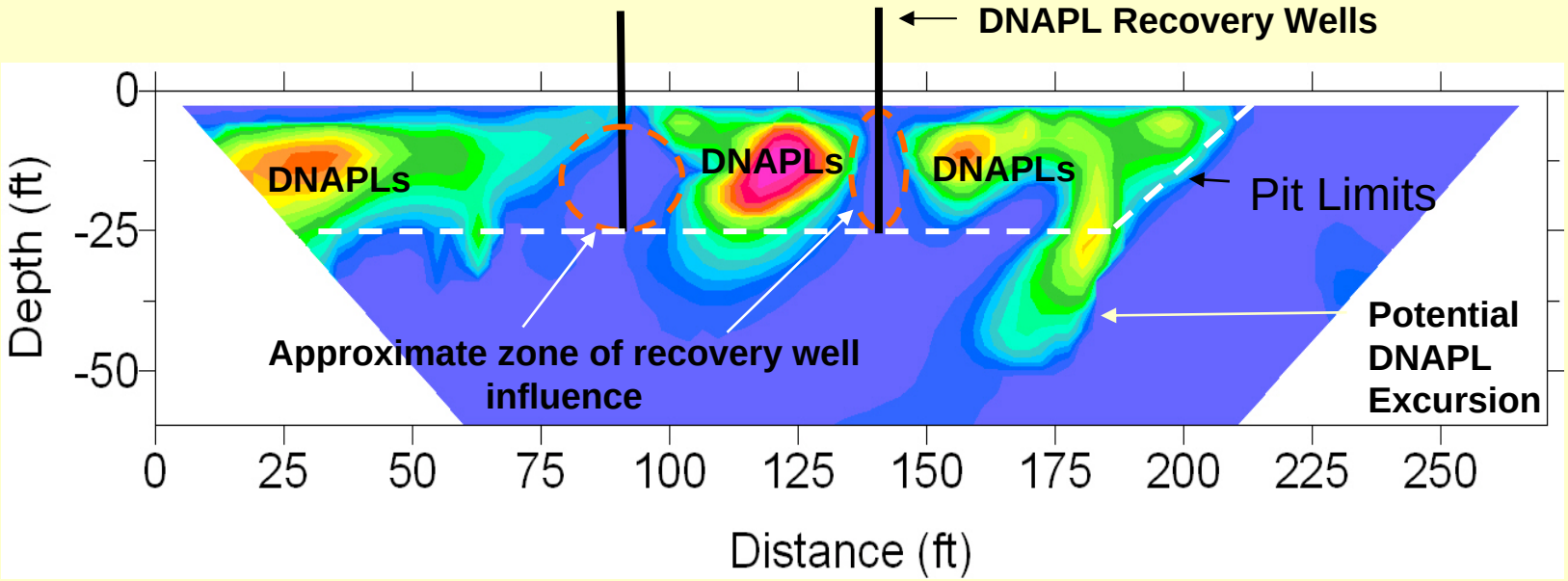
Post Other Data – Interpret ERI Data… if possible



Existing wells commonly not highly useful for confirmation

Do confirmatory drilling

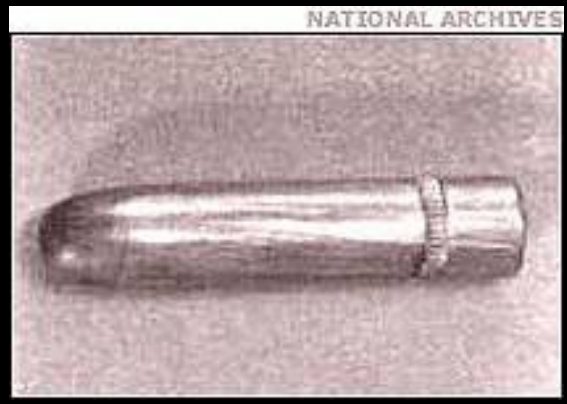
- ERI highs and lows are generally not where current data exists
- Wells not good for monitoring NAPL sites over long term

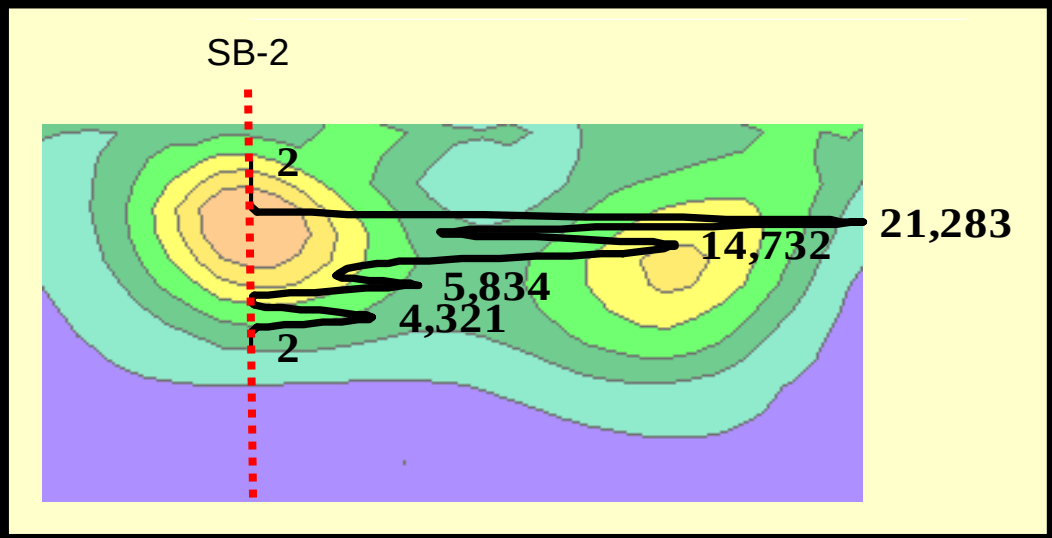


At the time the image was taken, wells were "clean" for 2 years

Note….

This is a magic bullet →





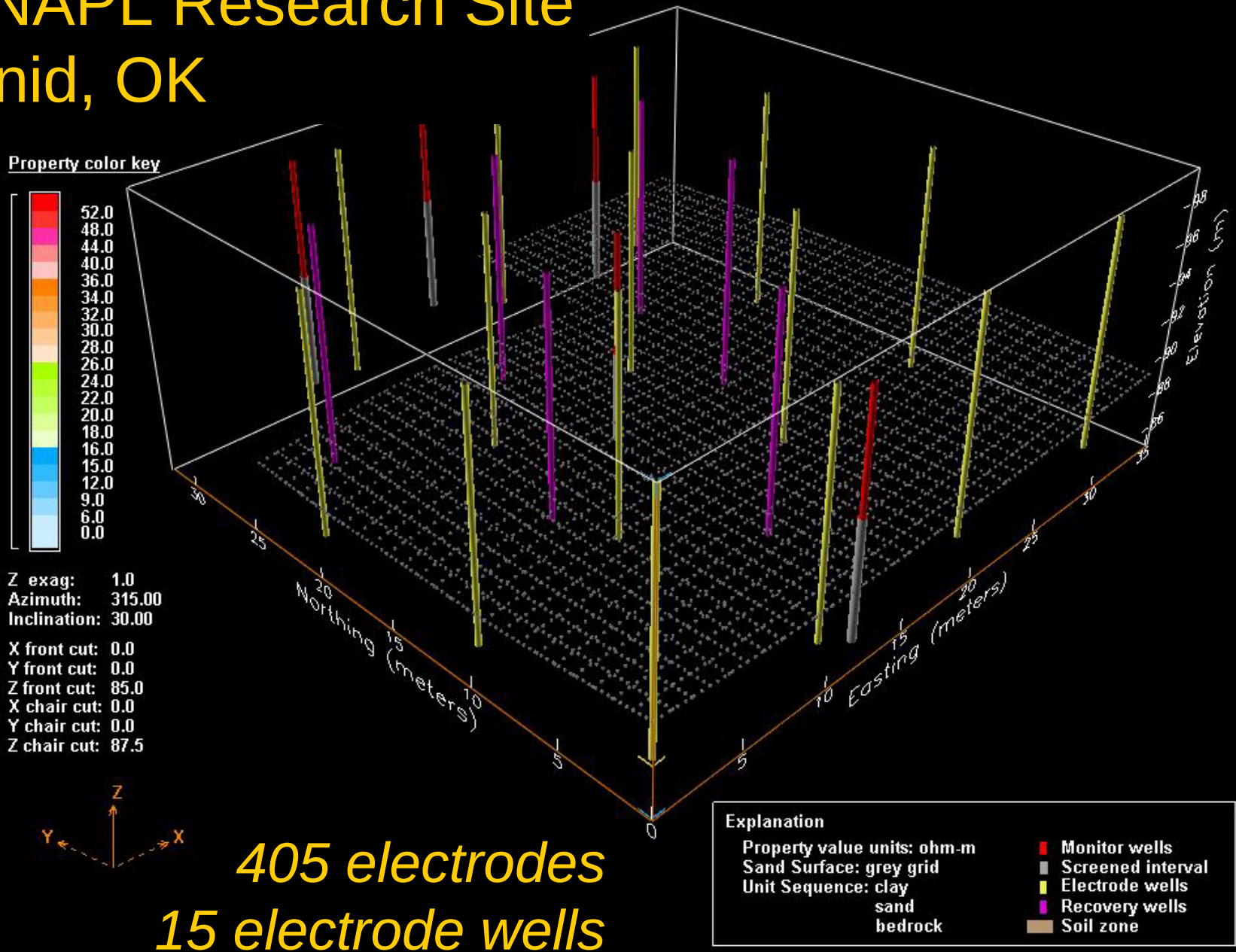
←This is not

Complex sites are still complex, you just have a better tool to obtain sufficient data.

Some Good News

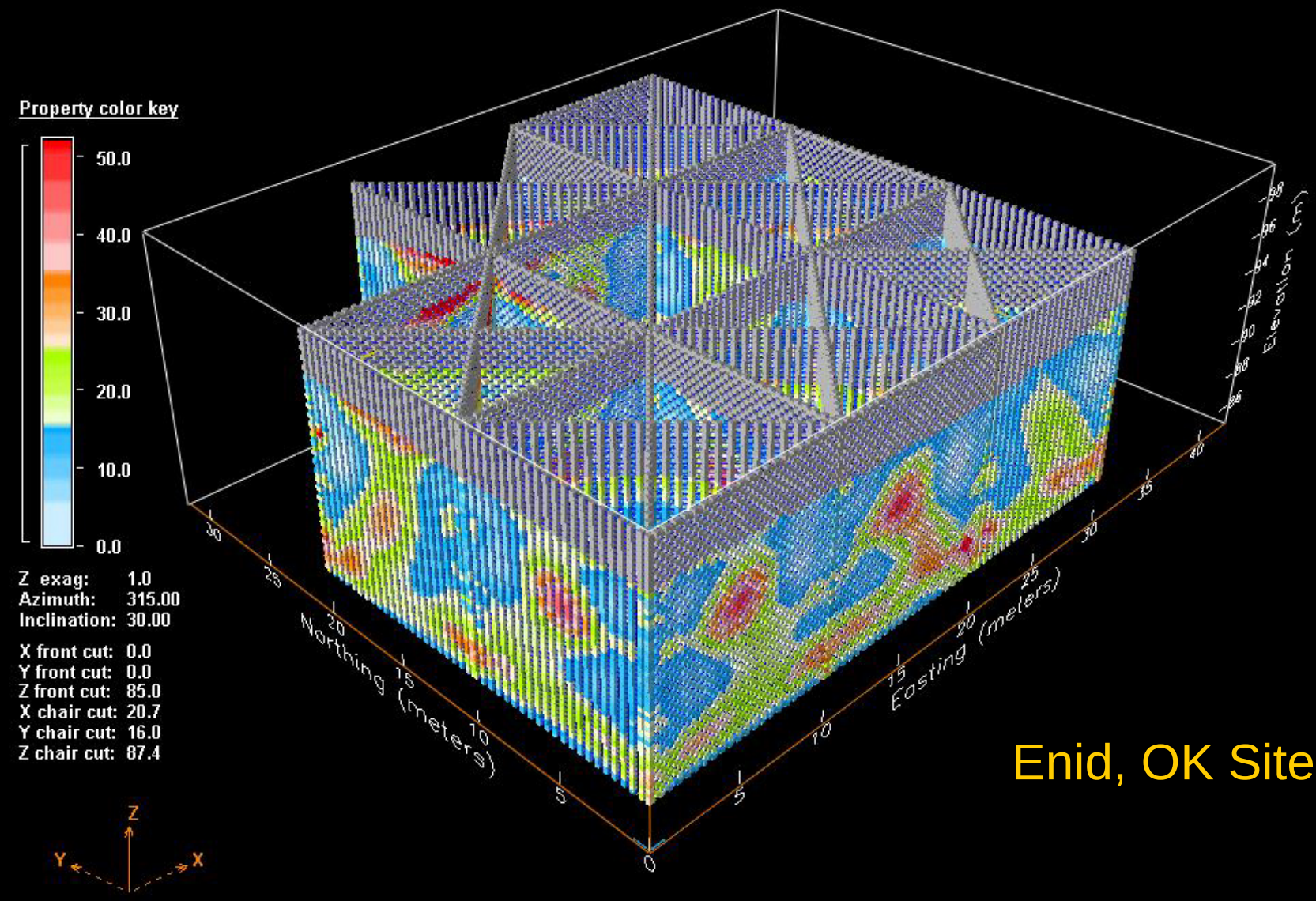
- ERI provides a great tool to allow sites to be better characterized
- Well data still critical because ERI is not a magic bullet; confirmation data is required to calibrate images
- Total impacted volumes are typically much less when estimated using ERI
- Visual tools provide increased ability to understand sites and communicate to project stakeholders

LNAPL Research Site
Enid, OK



405 electrodes
15 electrode wells

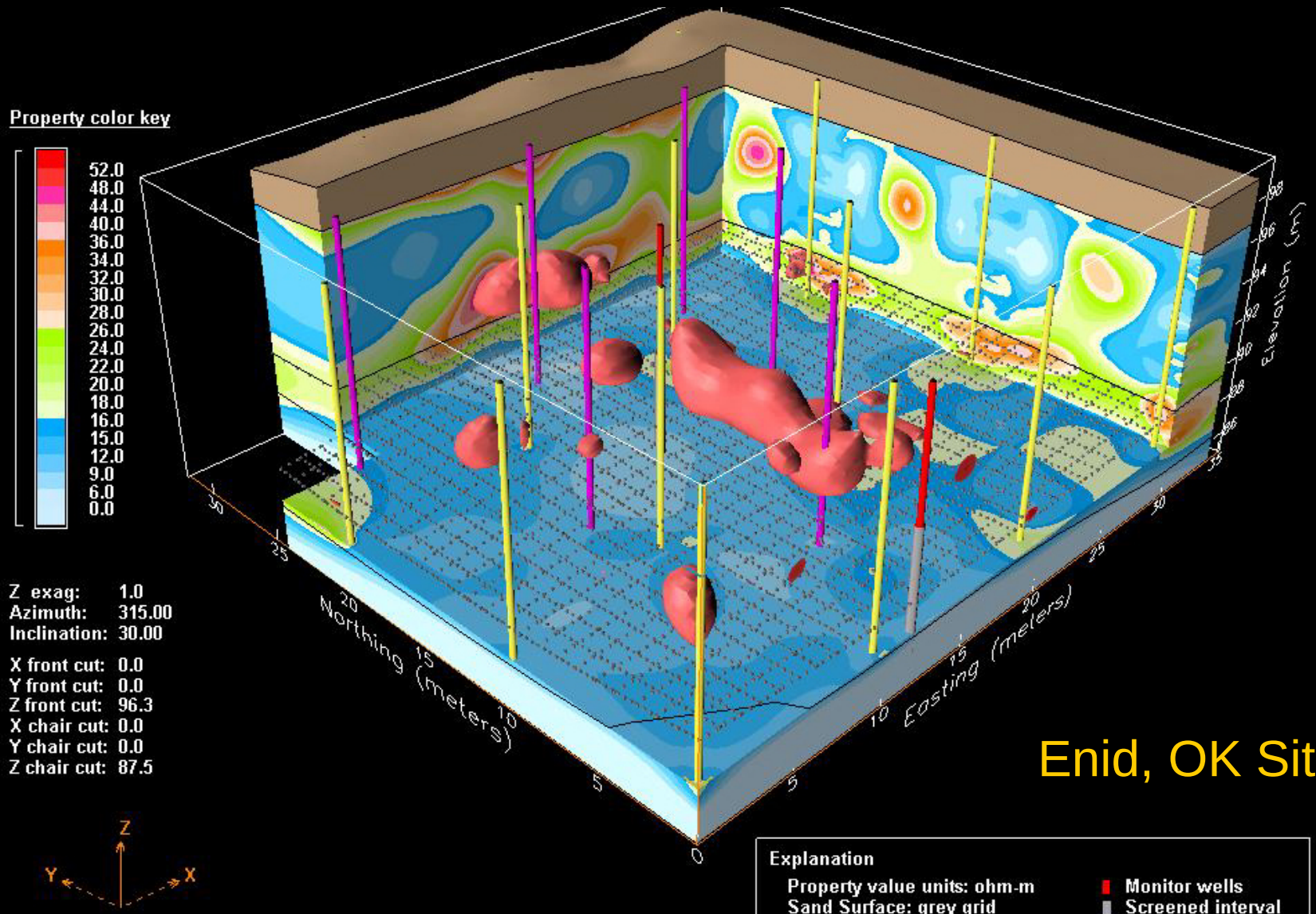
Dec 2002 – Pre-Remediation (Data Fences)



Dec 2002 – Site Dataset – 95,000 points

ERI movie

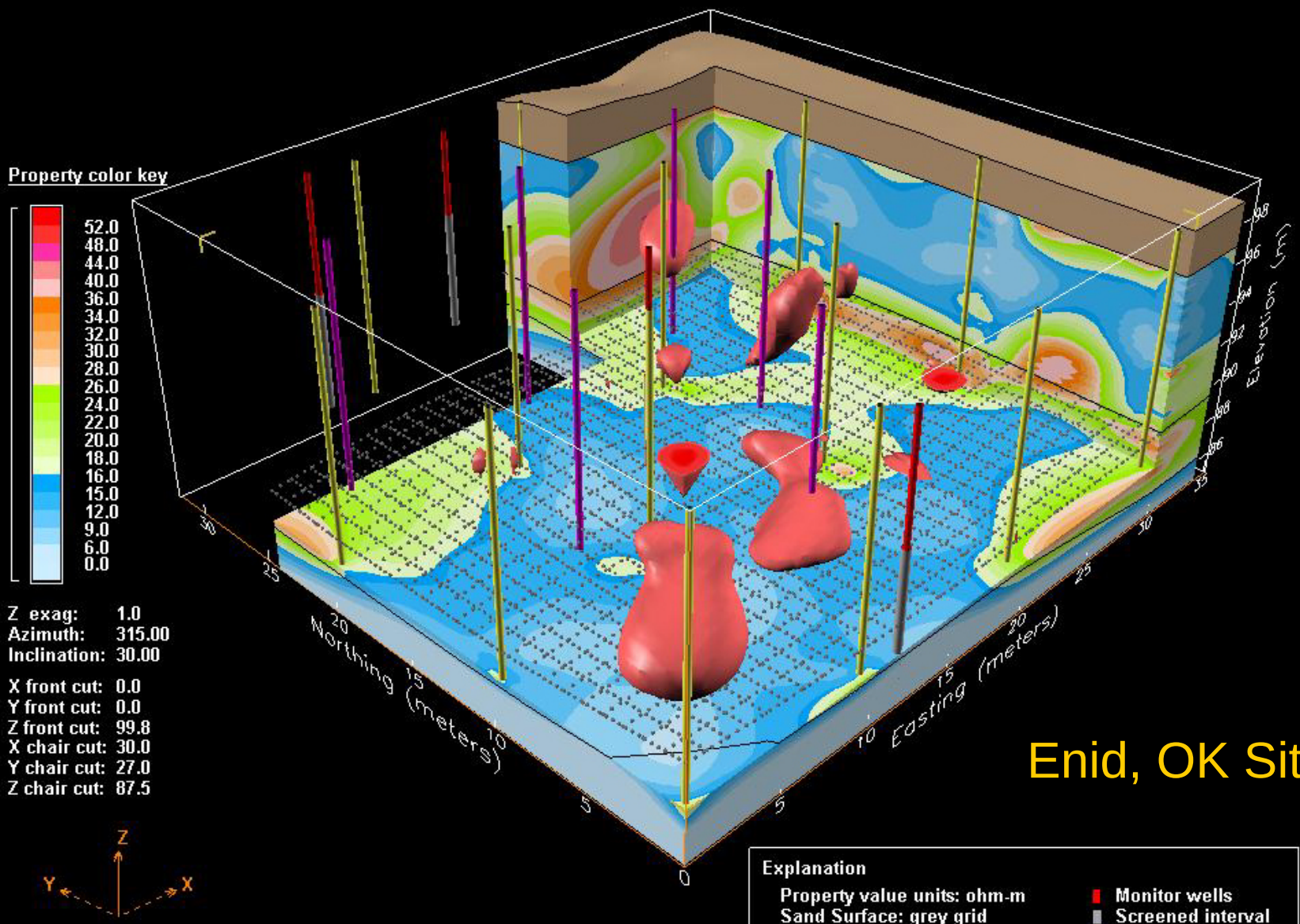
Dec 2002 – Pre-Remediation (46 ohm-m Isoshell)



Enid, OK Site

46 ohm-m ~ Free Product (LNAPL)

Aug 2003 – 7 months of remediation (46 ohm-m Isoshell)

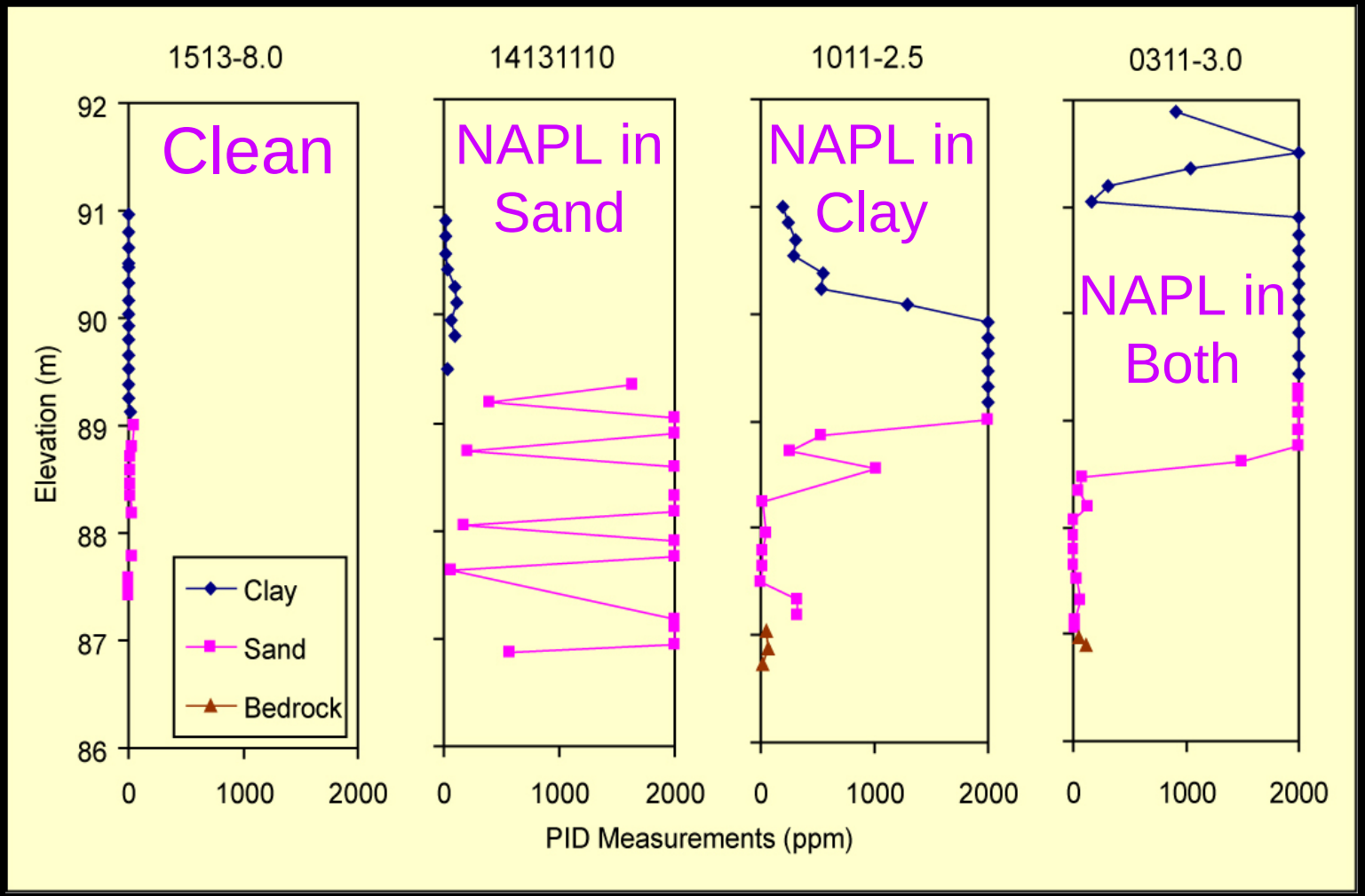


Enid, OK Site

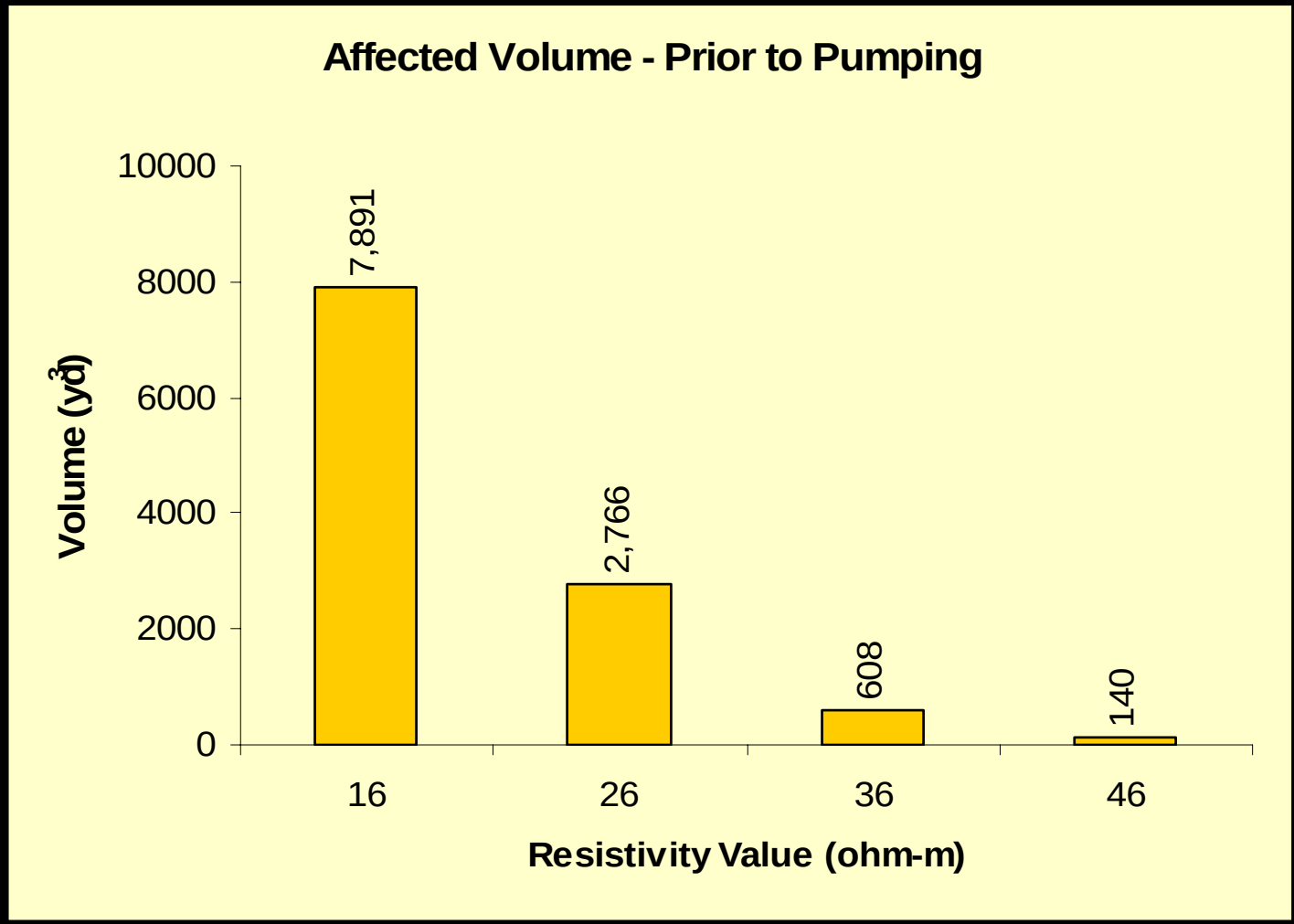
46 ohm-m ~ Free Product (LNAPL)

What would you like the Enid site conceptual model to be?

(all cores within 60 feet of each other)

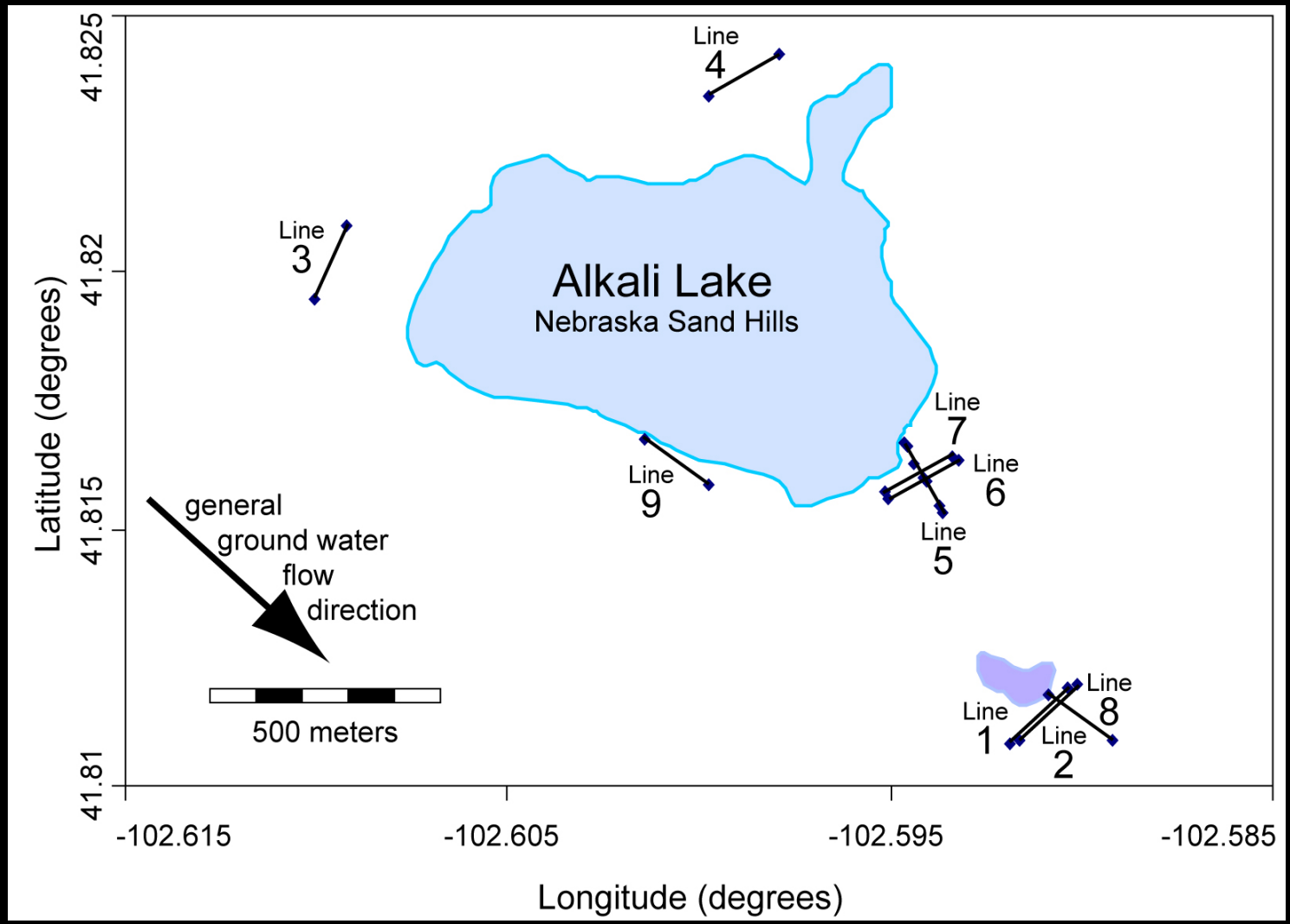


Sledgehammer vs. Surgical



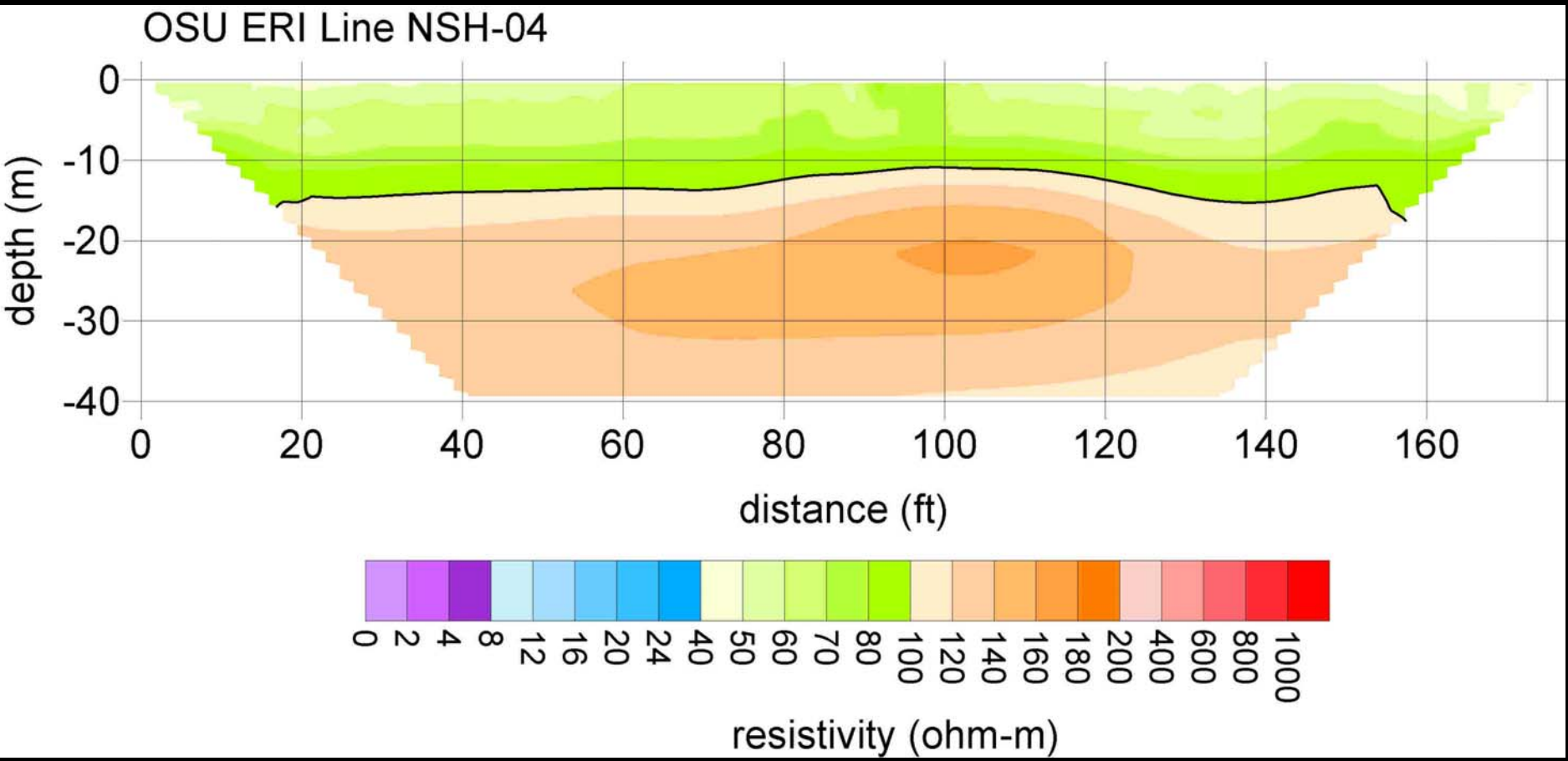
What volume needs to be remediated?

What about other issues?

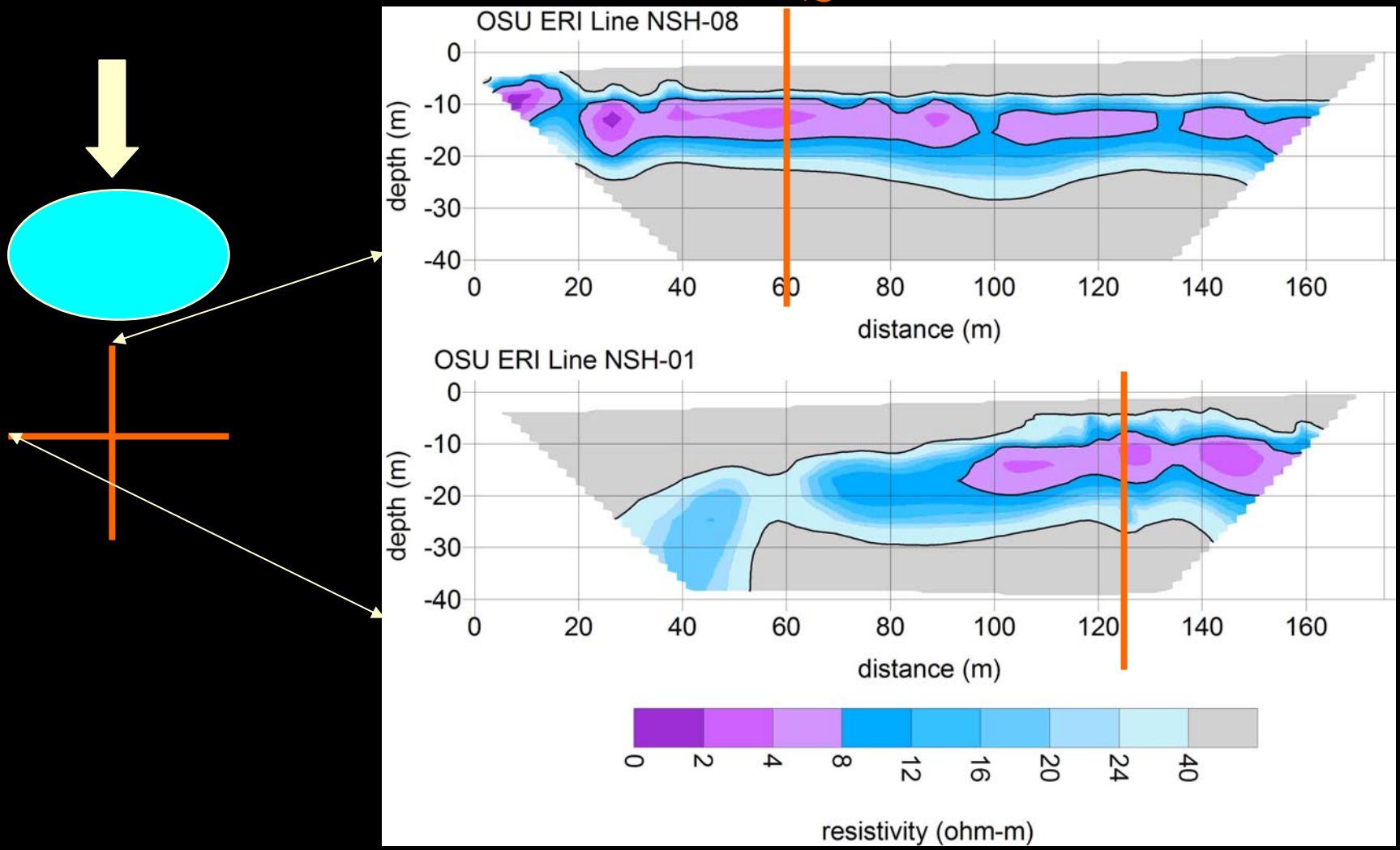


Upgradient of Alkali Lake - Nebraska

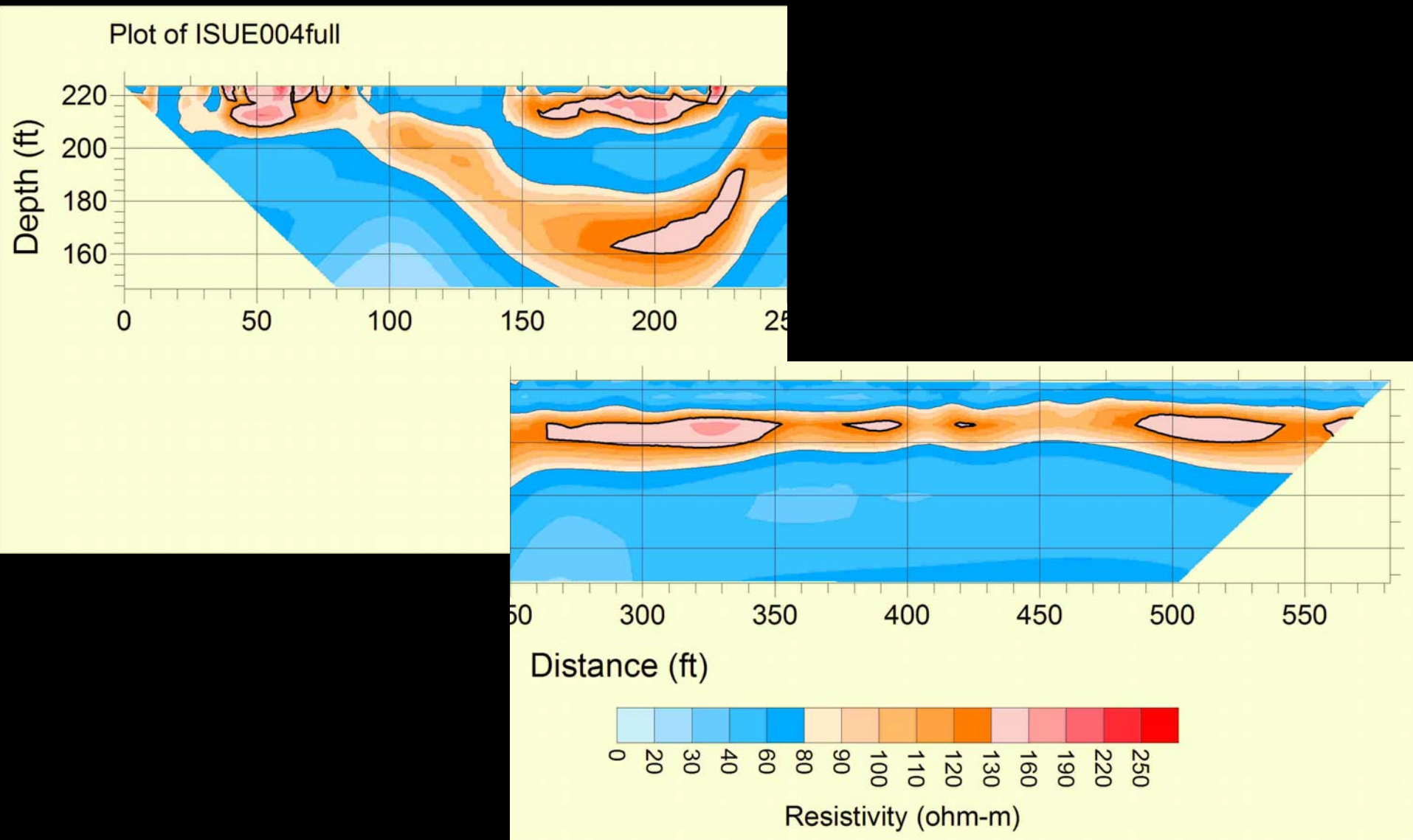
Background ERI (Fresh/Upgradient)

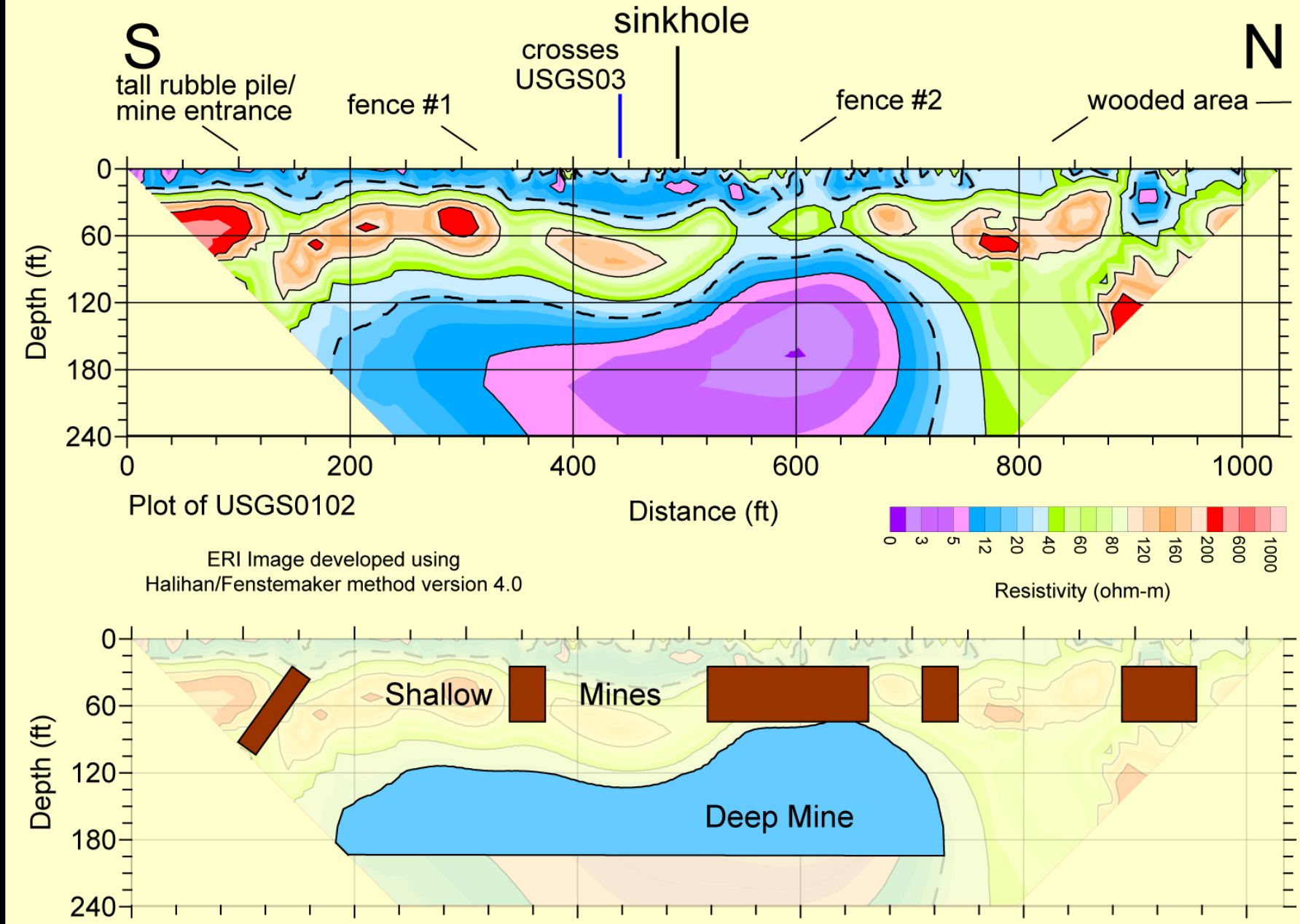


Downgradient of Saline Lake



The Lost Valley - Illinois




S
N
sinkhole
crosses USGS03
tall rubble pile/ mine entrance
fence #1
fence #2
wooded area
Depth (ft)
0
60
120
180
240
0
200
400
600
800
1000
Plot of USGS0102
Distance (ft)
ERI Image developed using
Halihan/Fenstemaker method version 4.0
0
3
5
12
20
40
60
80
120
160
200
600
1000
Resistivity (ohm-m)
Shallow
Mines
Deep Mine

GeoTrax ERI Advantages

- Provides cost effective remedial investigations
- “Surgical” investigation, design, and O&M
- Generates continuous “pictures” of the subsurface, using thousands of field data points
- Identifies source locations
- Confirm site is “clean” following remedial efforts
- Provides significant information that wells cannot

Stop the Taxi Meters

- Change in Site Conceptual Model
- Sources Can be Located and Removed
- Cost Effective Cleanup Methods
- Much Shorter O&M
- Much Shorter Monitoring Period
- Reduce Overall Risk and Liabilities

The Road to Come

- Sites will be characterized in 3D
- Geophysical techniques will be used
- Remediation will consume less time and money and be much more targeted
- Using only wells will get you pulled over
- Surface techniques will be used first


THANK YOU!
Questions?
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